

## WHAT IS CLAIMED IS:

1. A method for beneficiation of a mineral sulfide-containing material by froth flotation in the presence of a collector, the method comprising the steps of:

a) providing an aqueous slurry of the mineral sulfide-containing material.

b) adding a selective collector to the slurry, the collector comprising at least one oil selected from the group consisting of:

1) a natural oil or synthesized oil comprising:

A) triglycerides containing fatty acids of only 20 carbons or less, or

B) an ester made from a fatty acid and an alcohol; and

2) an essential oil;

c) selectively floating the mineral sulfide; and

d) recovering the mineral.

2. The method according to claim 1, wherein said mineral sulfide-containing material is selected from the group consisting of chalcocite, chalcopyrite, bornite, galena, sphalerite, pentlandite, molybdenite, and other sulfide minerals containing silver, gold, platinum, palladium, iridium, rhodium, and osmium, either in the crystal structure or in association as an independent mineral species, and combinations thereof.

3. The method according to claim 1, wherein said mineral sulfide-containing material is derived from ores, concentrates, precipitates, residues, tailings, slags, or wastes.

4. The method according to claim 1, wherein the essential oil comprises at least one of a terpene compound or an aromatic compound.

5. The method according to claim 1, wherein the essential oil comprises a terpene derivative having a functional group selected from an alcohol, an ether, an aldehyde, or a ketone.

6. The method according to claim 1, wherein said triglyceride further comprises a ketone, aldehyde, ether, or alcohol functional group(s)

7. The method according to claim 1, wherein the natural oil or the synthesized oil further comprises an aromatic functional group.

8. The method according to claim 1, wherein said collector further comprises a sulfur-containing sulfide mineral flotation promotor.

9. The method according to claim 8, wherein said oil and said sulfur-containing sulfide mineral flotation promotor are emulsified.

10. The method according to claim 8, wherein said sulfur-containing sulfide mineral flotation promotor is selected from the group consisting of xanthates, thionocarbamates, dithiophosphates, mercaptans and combinations thereof.

11. The method according to claim 8, wherein said collector further comprises a frother.

12. The method according to claim 1, wherein said collector further comprises a frother.

13. The method according to claim 1, wherein said collector further comprises a petroleum based flotation promotor.

14. The method according to claim 1, wherein the natural oil is selected from the group consisting of cottonseed, corn linseed, rice bran, safflower, soybean, avocado, jojoba, menhaden, lard, castor, cod liver, tung, oilcicaia, apricot, sunflower, pistachio, herring, and coconut; and the essential oil is selected from

the group consisting of limonene, citronella, eugenol, eucalyptus globus, camphor, and clove oil.

15. The method according to claim 1, wherein said natural oil is selected from the group consisting of cottonseed, corn, linseed, rice bran, safflower, soybean, avocado, jojoba, menhaden, lard, castor, cod liver, tung, and oiticicia; said synthetic oil is 2-butyloctyl oleic acid ester; and said essential oil is selected from the group consisting of limonene, citronella, eugenol, eucalyptus globus, camphor, and clove oil.

16. The method according to claim 1, wherein the collector comprises a natural oil selected from the group consisting of: cottonseed, corn, linseed, rice bran, safflower, soybean, avocado, jojoba, menhaden, lard, and castor.

17. The method according to claim 1, wherein the collector comprises a natural oil selected from the group consisting of: cottonseed, corn, linseed, rice bran, safflower, and soybean.

18. The method according to claim 1, wherein the collector comprises cottonseed oil.

19. The method according to claim 1, wherein the collector comprises an essential oil.

20. The method according to claim 19, wherein the collector comprises limonene or citronella.

21. The method according to claim 1, wherein the collector comprises a synthesized oil.

22. The method according to claim 21, wherein the collector comprises 2-butyloctyl oleic acid ester.

23. The method according to claim 1, wherein the collector comprises a blend of two or more of said natural oils, synthetic oils or essential oils.

24. A method for beneficiation of a metallic species of gold, silver, copper, palladium, platinum, iridium, osmium, rhodium, and ruthenium by froth flotation in the presence of a collector, the method comprising the steps of:

- a) providing an aqueous slurry of a material containing the metallic species, the material being derived from any ore, concentrate, residue, slag, or waste,
- b) adding a selective collector to the slurry, the collector comprising at least one oil selected from the group consisting of:
  - 1) a natural oil or synthesized oil comprising:
    - A) triglycerides containing fatty acids of only 20 carbons or less, or
    - B) an ester made from a fatty acid and an alcohol; and
  - 2) an essential oil;
- c) selectively floating the metallic species; and
- d) recovering the metallic species.

25. A collector for beneficiation of sulfide minerals, precipitates, or metallic species by froth flotation from ores, concentrates, residues, tailings, slags, or wastes, the collector comprising:

- a) at least one sulfur-containing sulfide mineral flotation promotor;
- and
- b) at least one oil selected from the group consisting of:
    - 1) a natural or synthesized oil comprising:
      - A) at least one triglyceride, or
      - B) at least one ester made from a fatty acid and an alcohol, and
    - 2) an essential oil.

26. The collector according to claim 25 wherein said flotation promotor is selected from the group consisting of xanthates, thionocarbamates, dithiophosphates, mercaptans and combinations thereof.

27. The collector according to claim 27 further comprising a frother.

28. The collector according to claim 28, wherein said frother is present in the amount of between 10 and 40% by weight of the collector.

5 29. The collector according to claim 25, wherein said essential oils are terpene based oils or aromatic oils and are present in an amount less than about 10% by weight of the collector.

10 30. The collector according to claim 25, wherein said oils are present in the amount of between 20 and 80% by weight of the collector, and said flotation promoters are present in the amount of between 80 and 20% by weight of the collector.

31. The collector according to claim 25, consisting essentially of at least one of said oils and at least one of said promoters.

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